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Seasonal dynamics during the late Holocene based on *Betula pubescens* leaves from a Danish lake core

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Proxies to infer changes in climate during the late Holocene in Denmark are scarce. Since vegetation has been significantly impacted by man during the past centuries, proxies such as pollen are difficult to apply. The undulation index (UI) of *Betula pubescens* epidermal cells provides a proxy that is not affected by human activities and allows inference of seasonal temperature changes. In this study, *B. pubescens* leaves where collected from a lake core taken at Lille Gribsø, Denmark. Preliminary results show structural fluctuations in epidermal cell properties during the last 1100 years. These fluctuations show some resemblance with reconstructions of solar intensity during the same period of time.

Materials and Methods

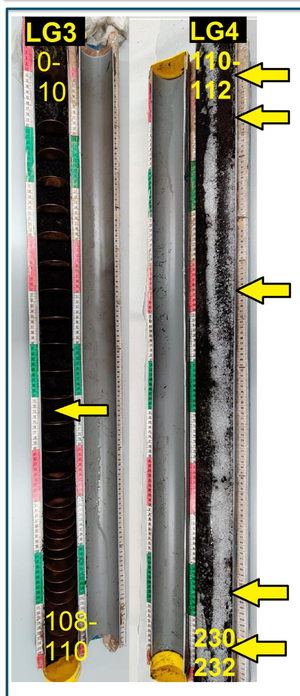

Fig. 2: Cores LG3 and LG4 from Lille Gribsø, Denmark. Yellow arrows indicate depths that have been aged.

Two cores where collected from Lille Gribsø, a small lake in Denmark (fig. 1). Six depths were ^{14}C dated (fig. 2). From these data, an age-depth model was constructed (fig. 3).

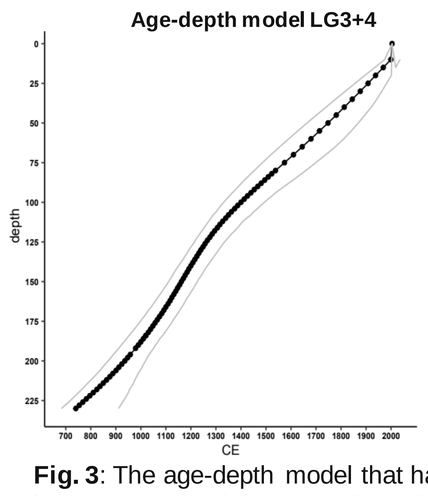

Fig. 3: The age-depth model that has been constructed for LG3+4 based on 6 ^{14}C dates.

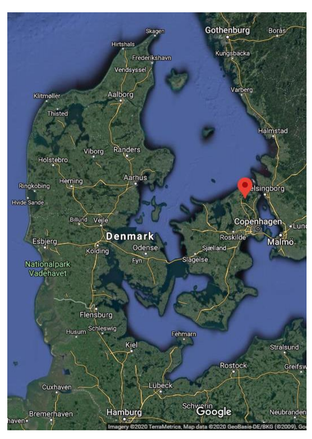

Fig. 1: Location of Lille Gribsø in Denmark (marked red).

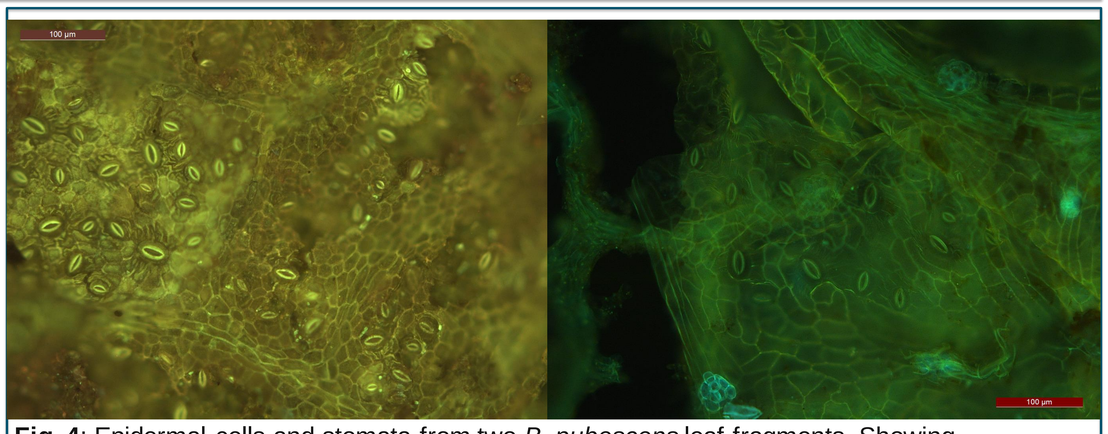

Fig. 4: Epidermal cells and stomata from two *B. pubescens* leaf fragments. Showing epidermal cells with a low undulation index (left) and epidermal cells with a high undulation index (right).

Leaves identified as *B. pubescens* where fotographed with a fluorescence microscope and the UI (Eq. 1) was determined from cuticle analysis. The UI has a positive correlation with growing season temperature and is applied to reconstruct growing degree values.

$$UI = \frac{CC}{2\pi\sqrt{\frac{CA}{\pi}}}$$

Eq. 1: Equation for calculation of the undulation index (UI) based on the mean Circumference (CC) and the mean area (CA) of the epidermal cells.

Preliminary Results

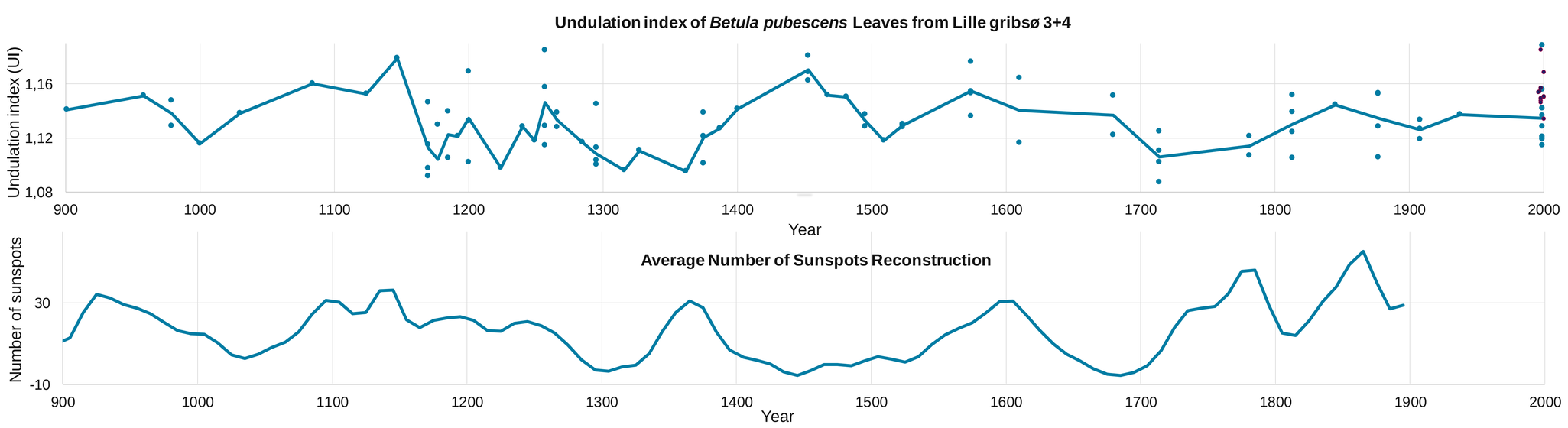

Fig. 5: UI values for 95 *B. pubescens* leaf fragments from LG3+4 (above). The blue line connects average UI values per depth. For comparison of trends in UI and solar intensity, the average number of suspots per decade has been depicted below (data from Solanki, S.K., et al. 2005).

Implications and Next Steps

Our preliminary results show that characteristics of epidermal cells from *B. pubescens* can serve as a valuable proxy for reconstruction of qualitative changes in seasonality in the past. The data density will further be increased to reach (multi-)decadal resolution. From the UI, GDD5 values will be inferred in the next step. By doing so, the undulation of epidermal cells of *B. pubescens* can provide new oppertunities for the inference of changes in climate during the late Holocene on a near decadal temporal resolution.